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Next Generation of Data Processing Faces Challenge in Sensors, Instrumentation

by Herb Egbert

While we now successfully develop complex environments to stimulate the Army's 21st century weapons and equipment, we face the more formidable challenge of gathering and processing the data from the test.

For example, we will need sensors which are not compromised by the high-intensity electromagnetic fields to which the test article is exposed. These must be hardened devices which can pick up small, subtle changes, operating at "microvolt levels." We will need optical and infrared instruments which can resolve on small submunitions telling us when and where they deployed.

Test technology then must provide us with the broadband, secure, multimedia transmission of data streams in the electronic environments. Once received, our processors must correlate, screen, format, and display information in near realtime.

Yes, 1996 technology at our test centers provides this data processing now, but the next generation must be faster. Why? Because we must be able to determine the proper functioning of high-speed weapon computers, and the loop on the remote control of drones and robotic systems participating in the test. The tester rule-of-thumb still says the "measuring stick" should be 10 times more accurate than the measured item.

The first challenge is the advancement needed in data sensing. The sensor must be correctly chosen, properly installed, and advantageously positioned. It must accurately measure data with minimum perturbation of the test media. Issues for sensor development requirements are:

- Sensors for testing neural network supported systems that go beyond a single decision-tree; that is, that manipulate and alter data in response to stimuli.
- Sensors for testing ergonomic efficiency of various systems.
- Types and uses of sensors for technical and operational testing of unmanned aerial vehicles and unmanned ground vehicles.
- Sensors for testing systems with terahertz speed computers that process 50 to 100 billion operations per second.
- Sensors for testing multispectral/multidomain weapon sensors with onboard data fusion and distribution capabilities.

- Sensors testing system vulnerability to high-energy laser, high-power microwave, and millimeter wave directed energy weapons.

While we are solving the sensor problem, we must not neglect the corollary conditioning and transmitting problem. Data from an instrumentation sensor usually have a very low-level output that needs amplification and other modifications. Data-conditioning instrumentation amplifies, converts, and combines the sensor output into a format more readily interfaced with data-transmitting systems. Data are regulated for mutual interaction, data fusion, and control of other instruments, and must be controlled to ensure minimum change from that read directly from the test article interface. Data-transmission processes may be as simple or as complex as test conditions dictate, from conventional hardwire connection and ordinary landlines to broadband, secure multimedia transport for wide-area and local-area telecommunications. Given that data are sensed, conditioned, and transmitted, the next steps are receipt, reduction, and analysis.

Raw data are consolidated, checked for accuracy, and arranged in a conventional order, and are summarized by elementary mathematical operations and description. Statistical test of hypothesis, planned data analysis, comparisons, and statistical significance levels are completed. Further analyses involve models and simulations and aggregation of common data from different sources. Application of human judgment to analytic results leads to conclusions, position statements, and challenges to validity of analysis.

The key test technologies needed, other than the sensors themselves, are:

- Subminiature telemetry packages (transmitters), hardened to withstand the firing shock and small enough to transmit data from on in-flight projectile.

- Methods for "piggybacking" test data using standard commo systems.

- Advanced correlation devices/algorithms for selecting best solution data from multiple sensors.

- Advanced data encryption techniques.

The "data challenge" is formidable, but vital to the tester. Data are the genesis of information, and the collection of accurate, timely information is the tester's "raison d'etre."

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